REMARKS

In response to the official action:

[1-3] The Examiner objected to the claims for informalities, and rejected the claims under 35 U.S.C. §112, second paragraph, as being indefinite. The claims are amended in view of the Examiner's remarks.

Regarding claim 3, reading "calculating information about areas of a top face and a bottom face of the solder from an image of the photographed solder," the rejection is respectfully traversed for the record and the Examiner is invited to consider that claim 1 now recites "side inclined portion." In the exemplary truncated cone or pyramid, the inclined faces are visible to the camera. Their lower edges border the bottom face and their upper edges border the upper face. The Applicants' method allows a good estimate even if the cream solder is not shaped as a perfect geometrical form.

[4-5] Claims 1-9 are rejected under 35 U.S.C. §102 as being anticipated by Ludlow (U.S. Patent 6,201,892). This rejection is respectfully traversed.

Ludlow discloses imaging solder balls using an illuminating ring 24 (Figs. 1-3) that produces a reflection highlight at about 45° from the spherical center of each solder ball, which provides information about the location, diameter and shape of each solder ball in a ball grid array (col. 10, lines 24-31, cited by the Examiner at page 4, line 6).

Ludlow also discloses obtaining two images made with two different illuminations, and then subtracting the two images to obtain a resulting image. However, the two illuminations of Ludlow are not from different portions of the illuminating ring.

Instead, Ludlow provides a single illumination from the entire ring, and a second illumination is from above (col. 13, lines 10-37).

Thus, Ludlow discloses subtracting two images respectively made with illuminating light from above and from a lateral direction, but does not disclose

> *irradiating the cream solder alternately with light from at least two illumination directions opposing each other, each of the illumination directions being substantially perpendicular to a viewing direction;*

as the Applicants' claim 1 recites. Ludlow discloses no alternation of light from opposed directions each perpendicular to the viewing direction.

The Examiner asserts that Ludlow discloses irradiating light from opposed directions (page 4, line 12) but this assertion is based on boxes 420 and 450 the flowchart of Fig. 17, that only recite illumination by a first light source and a second source. With respect, Fig. 17 gives no information about the illumination directions, which must be those from the entire ring and from above, that were already discussed. Fig. 17 by itself cannot disclose the Applicants' feature.

As to the claims depending from claim 1, these further distinguish over the reference. For example, Ludlow does not disclose calculating the volume, as is recited in claim 3. As noted, Ludlow does not disclose illuminating from segments of lights deployed in a ring-shape, or from four segments in an LED ring (claims 10 and 11), or from lines of lights (claim 10). Neither are the 5-10 of claim 12, or the truncated cone or truncated pyramid of claims 12 and 13 disclosed.

The second paragraph of claim 5 also recites the feature discussed above, and its dependent claims further distinguish in the same way as those of claim 1.

Similarly, independent claims 7, 8, and 9 all distinguish over Ludlow by reciting alternate illumination in opposing directions along the surface ("in a lateral direction") rather than from above.

[6] Claims 1, 3, and 5 are rejected under 35 U.S.C. §102 as being anticipated by Ngoi (U.S. Patent 6,525,331). This rejection is respectfully traversed.

Ngoi discloses a linear array of light sources L1, L2, ... L6 and a camera 13 that is centered in line with the linear array (Fig. 5). The light sources of the array are alternately illuminated in pairs (Fig. 8). A grating is placed above the ball grid array BGA, with the lines of the grating perpendicular to a plane formed by the BGA and the array (col. 3, lines 3-6). The shadows of the grating and various light sources produce moire patterns (col. 3, line 10).

Ngoi discloses illumination from two directions, but does not disclose irradiating light from *opposed* directions: the rays from the extreme ends of the array, L1 and L6, form approximately a right angle (Figs. 4 and 5).

In view of the aforementioned amendments and accompanying remarks, the claims are believed to be in condition for allowance. Withdrawal of the rejection and allowance of all claims is requested.

Attached hereto is a marked-up version of the changes made by the current amendment. The attached page is captioned, "VERSION WITH MARKINGS TO SHOW CHANGES MADE".

In the event this paper is not timely filed, then this paper is a petition for an appropriate extension of time. The fees for such an extension or any other fees which may be due with respect to this paper may be charged to Deposit Account No. 01-2340. Favorable consideration and allowance are respectfully solicited.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES

1. (amended) An inspection method for cream solder for determining whether or not the shape of the cream solder is appropriate based on information about [the height] a side inclined portion of the cream solder, the method comprising [by]

irradiating the cream solder alternately with light from [substantially besides in] at least two illumination directions opposing each other, each of the illumination directions being substantially perpendicular to a viewing direction; [through a lighting means to the cream solder so as to obtain]

obtaining [at least two] images along the viewing direction, the images corresponding to respective irradiations in the illumination directions; and

obtaining a difference between the obtained images.

2. (amended) An inspection method for the cream solder according to claim 1, wherein the steps of obtaining at least two images and obtaining a difference further comprise

[for determining whether or not the shape of the cream solder is appropriate by irradiating light to the cream solder in two directions opposing each other through the lighting means disposed substantially in the lateral direction of the cream solder,]

taking pictures of a reflection light from the cream solder with a camera disposed above,

obtaining a difference between at least two bright/dark images so as to [obtain aside] determine the inclination of an inclined portion of the cream solder from a luminance [thereof,] of the inclined portion, and

comparing [the] a value of the luminance of the inclined portion with a reference value set up preliminarily for determining whether or not the shape of the cream solder is appropriate.

3. (amended) An inspection method for the cream solder according to claim 1 wherein the solder is shaped generally as a truncated cone or generally as a truncated pyramid and is printed on a substrate, and wherein the method comprises [is photographed]

photographing the solder with a camera disposed above the substrate,

calculating information about areas of a top face and a bottom face of the solder [is obtained] from an image of the photographed solder and

computing an [the] amount of the solder [is computed] from [information of] the areas by an arithmetic operation.

4. (amended) An inspection method for the cream solder according to claim 1 wherein [light is irradiated to the cream solder from substantially beside in at least two directions opposing each other] the cream solder is on a circuit board and wherein the step of irradiating the cream solder with light from two directions comprises irradiating alternately from the two directions through a lighting means so as to obtain at least two images,

calculating a difference between the obtained images [is calculated] to gain information about [the height] a side inclined portion of the cream solder and then

[determine] determining whether or not [the] a shape of the cream solder is appropriate,

photographing with a camera [a reflection] light reflected from a non-soldered portion [such as a silk printed portion formed on a] of the printed circuit board [is photographed with the camera] and then

obtaining a difference between at least [the] two bright/dark images [is obtained] to remove the non-soldered portion from the [image.] difference between the obtained two images.

5. (amended) An inspection method for [the] cream solder wherein the solder is shaped generally as a truncated cone or generally as a truncated pyramid, comprising steps of

irradiating light [is irradiated] onto the cream solder from [substantially beside in] at least two illumination directions opposing each other alternately through a lighting means so as to obtain at least two images, each of the illumination directions being substantially perpendicular to a viewing direction;

calculating a difference between the [obtained] two images [is calculated] to gain information about [the height] a side inclined portion of the cream solder and then

determining whether or not the shape of the cream solder is appropriate [is determined] based on the information about the [height] side inclined portion.

6. (amended) An inspection method for the cream solder according to claim 5 wherein the solder is formed on a circuit board and

[light is irradiated to the cream solder from substantially beside in at least two directions opposing each other alternately through a lighting means so as to obtain at least two images, a difference between the obtained images is calculated to gain information about the height of the cream solder and then whether or not the shape of the cream solder is appropriate is determined based on the information about the height, and]

a reflection light from a non-soldered portion [such as a silk printed portion formed on a] of the printed circuit board is photographed with [the] a camera and then a difference between at least [the] two bright/dark images is obtained to remove the non-soldered portion from the image.

7. (amended) An inspection apparatus for [the] a cream solder on a printed circuit board, the apparatus comprising:

a camera disposed above [a] the printed circuit board which is subject [of] to inspection;

a lighting means disposed to irradiate substantially in [the] a lateral direction [of] relative to the cream solder applied to the printed circuit board and for irradiating light onto the cream solder in two directions opposing each other alternately;

an arithmetic operating portion which obtains a difference of luminance between at least two images of a side inclined portion of the cream solder photographed with said camera by alternately turning on the lighting means; and

a determining portion for deciding whether or not the shape of the cream solder is appropriate by comparing [the value of the] a luminance of a side inclined portion of the solder obtained by the arithmetic operating portion with a preliminarily set reference value.

8. (amended) An inspection apparatus for [the] a cream solder on a printed circuit board, the apparatus comprising:

a camera disposed above [a] the printed circuit board which is subject [of] to inspection;

a lighting means disposed to irradiate substantially in [the] a lateral direction [of] relative to the cream solder applied to the printed circuit board and for irradiating light onto the cream solder in two directions opposing each other alternately;

image processing means for [counting] determining dimensions and area of the solder from an image of the solder taken with the camera ;

arithmetic operating means for computing an amount of solder from the dimensions and area [counted] determined by the image processing means [to obtain the amount of the solder]; and

control means provided with a program for inspecting [the] a shape of the solder to control the [respective means.] apparatus.

9. (amended) An inspection apparatus for [the] a cream solder on a printed circuit board, the apparatus comprising:

a camera disposed above [a] the printed circuit board which is subject [of] to inspection;

a lighting means disposed to irradiate substantially in a lateral direction of a non-soldered portion [such as silk-printed portion] formed on the printed circuit board and for irradiating light onto the non-soldered portion in two directions opposing each other alternately; and

an arithmetic operating portion which switches the lighting means to obtain a difference between at least two images taken with the camera and removes the non-soldered portion from the image.